

## Data Analysis and Generalizations

## Catch a Piece of the Sun

### TEACHER GUIDE

#### BACKGROUND INFORMATION

The *National Science Education Standards* “Science as Inquiry” standard emphasizes the ability to think critically and logically about relationships between evidence and explanations, to construct and analyze alternative explanations, and to communicate scientific arguments. Prior to conducting investigations using solar wind data, students will need to have a basic understanding of the regimes of solar wind to provide the necessary context to be able to further explore the data in subsequent phases of this module.

In “Catch a Piece of the Sun,” students are provided background information about the Genesis mission and the three basic types of solar wind that are being detected by the Genesis Ion Monitor (GIM) and Genesis Electron Monitor (GEM). Students will develop an understanding of the Sun’s solar wind, and how the Genesis spacecraft collected solar wind at [L1](#). If your students have completed other Genesis education modules, you may want to skip this activity and begin with this module’s “Exploring Data” materials.



This guide provides some strategies for engaging students with the texts using a summary technique called “rule-based strategy.” The rule-based strategy was developed in 1981 by Brown, Campione, and Day and uses a set of rules that produce a summary. The rules include, (1) delete trivial material that is unnecessary to understanding; (2) delete redundant material; (3) substitute superordinate terms (e.g., “elements” for “silicon, aluminum, and gold”) for lists; and (4) select a topic sentence, or invent one if it is missing. In order to make these rules meaningful to students, it is important to show them how to do it. Procedure #5 below, provides information to help you demonstrate this strategy in detail. As students become familiar with this technique, they will be able to summarize on their own.

#### NATIONAL SCIENCE STANDARDS ADDRESSED

(Source – *National Science Education Standards*)

##### Grades 9-12

##### [Science As Inquiry](#)

Understandings about scientific inquiry

##### [Physical Science](#)

##### [Science and Technology](#)

(View a full text of the [National Science Education Standards](#).)

## MATERIALS

For each group of three to four students:

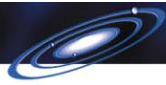
- Student Text, "[Solar Wind Catcher](#)"
- Student Activity, "[Summarizing](#)"
- Student Text, "[Solar Wind](#)"
- Fact Sheet, "[The Genesis Mission: An Overview](#)"
- Fact Sheet, "[How Does Studying the Solar Wind Tell Us About the Origin of Planets?](#)"

## PROCEDURE

1. Ask students to discuss why data collection is an important part of science. Possible discussion questions might include:
  - How are data used to ask and answer scientific questions?
  - What forms do data take? (Explain that numerical information is called quantitative data, while observational information is called qualitative data. Provide examples of each for students to observe).
  - In what ways can data be used to show trends?
  - How are data used to draw conclusions?
  - Why is data interpretation important?
  - How can data be misused? (Provide examples of bias in data.)
  - In what ways can data be used as evidence or to make decisions?

Explain to students that they will be making sense of actual solar wind data that has been sent back by the Genesis spacecraft. Before diving into the data, the following lesson will provide some context. Students will begin by exploring their own knowledge about the Sun and solar wind by participating in a K-W-L strategy. In this strategy, students list what they know about a subject from their experience or the experience of others. Next, students list what they want to find out by listing questions about the topic. Prior to reading the student texts, students discuss questions to help activate their background knowledge and establish a sense of the information that they will read. Finally, in the last part of the strategy, students list what they have learned about the topic.

2. Ask students to consider what they know about the Sun and solar wind. During your discussion, think about ways to elicit student interest. Some students might relate to issues with solar flares or solar storms and their impact on cell phones or communications satellites. Other students may relate experiences of seeing or reading about auroras. List the responses on the board. Do not address misconceptions at this point; rather use this information to inform your instruction. Information found in the public module "[Solar Wind, Genesis, and the Planets](#)" may be useful to stimulate this discussion. For more information, see: [http://genesissmission.jpl.nasa.gov/science/module4\\_solarmax/Effects.html](http://genesissmission.jpl.nasa.gov/science/module4_solarmax/Effects.html)
3. The second part of this strategy involves eliciting student questions about the Sun and solar wind. Again, write responses on the board. If questions about the Sun's makeup do not come up, lead students to consider the elemental makeup of the Sun. Questions might include: "What is the Sun made up of?" "What are the precise elemental and isotopic abundances in the Sun?" Explain that the Genesis mission's objectives are to find the answers to these questions by collecting solar wind. Distribute the two fact sheets about the Genesis mission and the science involved in the mission. Ask students to read these two fact sheets.
4. Distribute the Student Text, "[Solar Wind Catcher](#)," and Student Activity, "[Summarizing](#)," to each student. This activity uses a summarizing technique called the Rule-Based Strategy that will help students make sense of the information. Explain to students that this text provides brief information about the instruments that the Genesis spacecraft is using to collect solar wind and detect the type of solar wind that the Sun emits. This text makes use of video clips of researchers from the Los Alamos National Laboratory describing these instruments. Assemble students into groups of two or three. For students who are interested in additional information, refer them to the "[Dynamic Design: A Collection Process](#)" module.



5. Explain the steps of the Rule-Based Strategy:
- Delete trivial material that is unnecessary to understanding.
  - Delete redundant material.
  - Substitute superordinate terms for lists (e.g., “elements” for “silicon, aluminum, and gold”).
  - Select a topic sentence. If none exists, create one.

**Alternate Strategy Tip**

Make the Student Activity, “Summarizing,” into a transparency so you can demonstrate this technique with your students by using the first two paragraphs of the student text.

**Guiding Students Through the Summarizing Technique**

Ask students to read the first two paragraphs of the Student Text, “Solar Wind Catcher,” silently. Encourage them to complete the “Summarizing” activity sheet as you talk them through the process:

“Since the first paragraph is background information, what would be a good summary topic sentence?” One example might be “The Genesis spacecraft is collecting pieces of the Sun so that scientists will know more about the beginnings of our solar system.”

One rule states that redundant and trivial material should be deleted. In the second paragraph, we can delete information about the hexagonal wafers, so that instead of:

“The wafers are mounted on five collector arrays that are 73 cm in diameter on the Genesis payload. Each array consists of 42 hexagon wafers and 13 incomplete hexagon wafers. The wafers are placed on the array so that there is one centimeter of space between them. There are four arrays stacked together in the container and one found on the lid. The lower stacked arrays are shaded from the solar wind when not in use. The top and the one in the lid will be used to collect bulk solar wind (they will always be exposed). The bottom three in the stack will be used to collect specific regimes of solar wind.”

we can say:

“Most of the solar wind collectors are constructed of hexagon-shaped wafers that maximize the collection area on each array frame. Two of the arrays are always exposed while the other three are controlled to collect a certain kind of solar wind.”

We can also substitute superordinate terms for lists, so rather than stating that:

“Most of the wafers are made from silicon, though some are aluminum and gold, diamond, and germanium,”

we can say:

“These collectors are made from very pure and clean hexagonal wafers made up of a variety of materials.”

The last part of the paragraph contains information that is not trivial or redundant, but we can make it simpler. Let’s try this:

“After its two year sunbath, Genesis will return to Earth where the scientists will use the variety of wafer materials to analyze the amounts of various elements and isotopes.”

So now, the first two paragraphs can be combined to read:

The Genesis spacecraft is collecting pieces of the Sun so that scientists will know more about the beginnings of our solar system. Most of the solar wind collectors are constructed of hexagon-shaped wafers that maximize the collection area on each array frame. Two of the arrays are always exposed while the other three are controlled to collect a certain kind of solar wind. These collectors are made from very pure and clean hexagonal wafers made up of different materials. After its two-year sunbath, Genesis will return to Earth where the scientists will use the variety of wafer materials to analyze the amounts of various elements and isotopes.

6. Ask students to practice using this Rule-Based Strategy to summarize the remaining paragraphs in this text. You may want to have students work in four groups. Each group could summarize one of the following sections: "Instruments," "The Concentrator," "The Monitors," and "From Spacecraft to Earth." Circulate around the room and make sure that students are summarizing the materials using the rules. In the end, students should have summaries that are meaningful to them.
7. Distribute the Student Text, "Solar Wind," to each student, asking them to use the same Rule-Based Strategy that was used in procedure #4 above. This time, ask students to summarize the text using the technique on their own, perhaps as a homework assignment. Explain that this text provides brief information about the solar wind and the three regimes (basic types) that scientists classify. This text makes use of a video clip of a solar scientist from the Los Alamos National Laboratory explaining these regimes. For students who are interested in additional information, refer them to the "[Cosmic Chemistry: The Sun and Solar Wind](#)" module.
8. Complete this lesson by asking students to describe in their own words what they have learned about the solar wind and how it is collected. List responses on the chalkboard. Explain that in the next activity, students will get a chance to observe real solar wind data as obtained by the Genesis spacecraft.

## TEACHER RESOURCES

Brown, A.L., Campione, J.C., & Day, J. (1981). Learning to learn: On training students to learn from texts. *Educational Researcher*, 10, 14-24.

Marzano, R.J., et al. (2001). *Classroom Instruction that Works*. Alexandria, VA: Association for Supervision and Curriculum Development.